CLAIMS

1. A thrust converter comprising:

a reciprocating means;

a reciprocation-to-rotation converting means for converting a reciprocating motion of the reciprocating means into a rotary motion;

a rotation-to-reciprocation converting means located on the same axial line as that of the reciprocation-to-rotation converting means for converting the rotary motion of the reciprocation-to-rotation converting means into a reciprocating motion;

a reaction force receiving means for receiving reaction force against the reciprocating motion of the rotation-to-reciprocation converting means; and

a moving means for moving the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means in an axial direction separately from driving force due to the reciprocating motion of the reciprocating means.

2. The thrust converter according to Claim 1, wherein when the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means are moved by the moving means, a quantity of the movement is absorbed by a part of the reciprocating means.

3. The thrust converter according to Claim 1, wherein the moving means includes:

a connection means having a first screw, and a second screw thread-engaged with the first screw; and

a driving means for driving rotation of at least one screw of the connection means to thereby move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means.

4. The thrust converter according to Claim 1, wherein the moving means includes:

a connection means having a first screw, and a second screw thread-engaged with the first screw;

a driving means for driving rotation of both screws of the connection means to thereby move ~~the~~ reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means; and

a rotation transferring means constituted by gears and interposed between the driving means and the connection means for transferring the driving force of the driving means so that the first and second screws of the connection means rotate at different rotational velocities.

5. The thrust converter according to Claim 1, wherein the moving means includes:

a connection means having a first screw, and a second screw thread-engaged with the first screw;

a driving means for driving rotation of at least one screw of the connection means to thereby move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means; and

a transfer/disconnection means interposed between the driving means and the connection means for transferring the driving force of the driving means to the coupling means and disconnecting the transfer.

6. The thrust converter according to Claim 1, wherein the moving means includes:

a motor having a feed screw on its rotary shaft;

a moving shaft thread-engaged with a feed screw portion of the rotary shaft so that the moving shaft moves axially with the rotation of the rotary shaft and stops in a predetermined position to rotate;

a first driving gear provided on the moving shaft; a second driving gear provided on the moving shaft at a predetermined distance from the first driving gear;

a connection means having a first screw, and a second screw thread-engaged with the first screw;

a first driven gear provided on the first screw of the connection means so as to mesh with the first driving gear;

and

a second driven gear provided on the second screw of the connection means so as to mesh with the second driving gear and having teeth different in number from those of the first driven gear,

wherein the motor is driven to move the moving shaft to a position where the first and second driving gears and the first and second driven gears mesh with each other simultaneously;

the moving shaft is stopped in this position and driven to rotate to thereby drive the first and second screws of the connection means to rotate by differential motion through the first and second driving gears and the first and second driven gears to move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means to predetermined positions; and

when the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means are moved to the predetermined positions, the moving shaft is moved to a position where the first and second driving gears do not mesh with the first and second driven gears respectively.

7. The thrust converter according to Claim 1, wherein the moving means includes:

a motor having a feed screw on its rotary shaft;

a moving shaft thread-engaged with a feed screw portion of the rotary shaft so that the moving shaft moves axially with rotation of the rotary shaft and stops in a predetermined position to rotate;

a driving gear provided on the moving shaft;

a connection means having a first screw, and a second screw thread-engaged with the first screw;

a driven gear provided on the first screw of the connection means so as to mesh with the driving gear; and

a whirl-stop means for whirl-stopping the second screw of the connection means at a desired time,

wherein the motor is driven to move the moving shaft to a position where the driving gear and the driven gear mesh with each other;

the moving shaft is stopped in this position and driven to rotate while the second screw is whirl-stopped by the whirl-stop means to thereby drive the first screw of the connection means to rotate through the driving gear and the driven gear to move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means to predetermined positions; and

when the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means are moved to the predetermined positions, the moving shaft is moved to a position where the driving gear does not mesh with the driven

gear.

8. The thrust converter according to Claim 1, wherein the moving means includes:

a connection means having a first screw, and a second screw thread-engaged with the first screw;

a motor using the first screw of the connection means as a rotor; and a whirl-stop means for whirl-stopping the second screw of the connection means at a desired time,

wherein in a condition that the second screw of the connection means is whirl-stopped by the whirl-stop means, the motor is driven to drive the first screw of the connection means to rotate to thereby move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means to predetermined positions.

9. The thrust converter according to Claim 1, wherein the moving means includes:

a connection means having a first screw, and a second screw thread-engaged with the first screw;

a first motor using the first screw of the connection means as a rotor; and

a second motor using the second screw of the connection means as a rotor,

wherein in a condition that the second screw of the

connection means is whirl-stopped by excitation of the second motor, the first motor is driven to drive the first screw of the connection means to rotate to thereby move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means to predetermined positions.

10. The thrust converter according to Claim 1, wherein the moving means includes:

a connection means having a first screw, and a second screw thread-engaged with the first screw; and

a motor using the first screw of the connection means as a first rotor and using the second screw of the connection means as a second rotor, the first rotor being different in number of poles from the second rotor,

wherein the motor is driven to drive the first and second screws of the connection means to rotate to thereby move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means to predetermined positions.

11. The thrust converter according to any one of Claims 1 through 10, wherein the reciprocating means includes:

a motor; and

a motor rotation-to-reciprocation converting means for

converting a rotary motion of the rotary shaft of the motor into a reciprocating motion.

12. The thrust converter according to any one of Claims 1 through 10, wherein the reciprocating means includes:

a motor disposed on an axis different from the axial line of the reciprocation-to-rotation converting means;

a motor rotation-to-reciprocation converting means disposed on the same axis as the axial line of the reciprocation-to-rotation converting means for converting a rotary motion of the rotary shaft of the motor into a reciprocating motion; and

a motor rotation transferring means for transferring the rotation driving force of the motor to the motor rotation-to-reciprocation converting means.

13. The thrust converter according to any one of Claims 1 through 10, wherein the reciprocating means includes:

a motor disposed on an axis different from the axial line of the reciprocation-to-rotation converting means;

a motor rotation-to-reciprocation converting means disposed on an axis the same as an axial line of a rotary axis of the motor for converting a rotary motion of the rotary shaft of the motor into a reciprocating motion; and

a thrust transferring means for transferring an axial

thrust force of the motor rotation-to-reciprocation converting means to the reciprocation-to-rotation converting means.

14. The thrust converter according to Claim 13, wherein the motor rotation-to-reciprocation converting means has a screw provided on the rotary shaft of the motor, and a nut thread-engaged with the screw; and

the thrust transferring means has a reciprocating portion for supporting a bearing for rotatably bearing the reciprocation-to-rotation converting means, and a thrust transfer plate for connecting the reciprocating portion and the nut to each other.

15. The thrust converter according to Claim 14, wherein the thrust transfer plate is connected to the nut through a flexible coupling.

16. The thrust converter according to any one of Claims 3 through 13, wherein one screw of the connection means is rotatably supported with respect to the reciprocation-to-rotation converting means.

17. The thrust converter according to any one of Claims 3 through 13, wherein one screw of the connection means is rotatably supported with respect to the

reciprocation-to-rotation converting means; and

the other screw of the connection means is rotatably supported with respect to a part of the reaction force receiving means.

18. The thrust converter according to Claim 7 or 8, wherein the whirl-stop means is constituted by an electromagnetic brake; and

a part of the whirl-stopped screw of the connection means is provided as a brake disk.

19. The thrust converter according to Claim 7 or 8, wherein the whirl-stop means is constituted by an electromagnetic brake; and the second screw prohibited from rotating by the electromagnetic brake is connected to an external driving means.

20. A control method for controlling a thrust converter defined in Claim 1, comprising the steps of:

driving the moving means to move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means to predetermined positions; and

driving the reciprocating means after the arrival of the reciprocation-to-rotation converting means and the

rotation-to-reciprocation converting means at the predetermined positions to thereby operate the reciprocating portion of the rotation-to-reciprocation converting means through the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means.

21. A control method for controlling a thrust converter defined in Claim 1, comprising the steps of:

performing an operation in a first operation mode in which, in a condition that the moving means is stopped, the reciprocating means is driven to operate the reciprocating portion of the rotation-to-reciprocation converting means through a reciprocation-rotation means and the rotation-to-reciprocation converting means;

performing an operation in a second operation mode in which the moving means is driven to move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means; and

limiting driving force for at least one of the reciprocating means and the moving means when thrust force is generated.

22. A controller for controlling a thrust converter defined in Claim 1, comprising:

means for driving the moving means to move the

reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means to predetermined positions and for driving the reciprocating means after the arrival of the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means at the predetermined positions to thereby operate the reciprocating portion of the rotation-to-reciprocation converting means through the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means.

23. A controller for controlling a thrust converter defined in Claim 1, comprising:

means for performing an operation in a first operation mode in which, in a condition that the moving means is stopped, the reciprocating means is driven to operate the reciprocating portion of the rotation-to-reciprocation converting means through a reciprocation-rotation means and the rotation-to-reciprocation converting means, for performing an operation in a second operation mode in which the moving means is driven to move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means, and for limiting driving force for at least one of the reciprocating means and the moving means when thrust force is generated.

24. A method for controlling a thrust converter defined

in Claim 6 or 7, comprising the steps of:

making sensors detect the positions of teeth of the driving gear and the driven gear when the driving gear is made to mesh with the driven gear; and

rotating the gears at angles enabling the mesh on the basis of signals detected by the sensors.

25. A controller for controlling a thrust converter defined in Claim 6 or 7, comprising:

a plurality of sensors for detecting the positions of teeth of the driving gear and the driven gear; and

means for rotating the gears at angles enabling gear mesh on the basis of signals detected by the sensors when the driving gear is made to mesh with the driven gear.

26. A controlling method for controlling a thrust converter defined in Claim 6, comprising the steps of:

storing gear angles at a time of shifting from a gear mesh state to a gear separation state;

stopping rotation of the first and second driving gears in the gear separation state; and

rotating the first and second driven gears at the stored gear angles when the first and second driving gears are made to mesh with the first and second driven gears from the gear separation state.

27. A controller for controlling a thrust converter defined in Claim 6, comprising:

a storage means for storing gear angles at the time of shifting from a gear mesh state to a gear separation state;

means for stopping the rotation of the first and second driving gears in the gear separation state; and

means for reading the gear angles stored in the storage means and rotating the first and second driven gears at the gear angles when the first and second driving gears are made to mesh with the first and second driven gears from the gear separation state.

28. A method for controlling a thrust converter defined in Claim 1, comprising the steps of:

performing an operation to drive the moving means and the reciprocating portion of the rotation-to-reciprocation converting means in reverse directions to each other; and

restoring the thrust converter to an origin on the basis of a position where the thrust converter at an operating range limit due to a mechanism limitation of either a mechanical stopper or the thrust converter.

29. A controller for controlling a thrust converter defined in Claim 1, comprising:

means for performing an operation to drive the moving means and the reciprocating portion of the rotation-to-reciprocation converting means in reverse directions to each other and for restoring a position arriving at an operating range limit due to a mechanism limitation of either a mechanical stopper or the thrust converter to the origin.

30. A controller for controlling a thrust converter defined in Claim 1, comprising:

a high-order controller;

a first controller for controlling the moving means; and

a second controller for controlling the reciprocating means,

wherein in a second operation mode in which the moving means is driven to move the reciprocation-to-rotation converting means and the rotation-to-reciprocation converting means, the first controller controls the moving means on the basis of an instruction given from the high-order controller and outputs an instruction based on a quantity of movement of the moving means to the second controller, and the second controller controls the reciprocating means on the basis of the instruction based on the quantity of movement of the moving means from the first controller; and

in a first operation mode in which the reciprocating means

is driven to operate the reciprocating portion of the rotation-to-reciprocation converting means through a reciprocation-rotation means and the rotation-to-reciprocation converting means in a condition that the moving means is stopped, the second controller controls the reciprocating means on the basis of an instruction outputted from the high-order controller and inputted through the first controller.